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A Improved Prognostic Weighted Clustering Method to Lower Overheads in Mobile Ad-hoc Networks

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ABSTRACT

By choosing the best candidate to be the cluster leader, our enhanced forecast weighted clustering algorithm (EFWCA) can lower the computational overhead. This innovative method increases network stability and can manage massive traffic. Routing problems are common in wireless mobile ad hoc networks (MANET) because of their unpredictable nature and limited resources. Since there is no central router in ad hoc networks, routing is a crucial method for data transmission. Each node acts as a router. Numerous routing strategies, many of which employ the flooding method, have been recommended in order to find a route. By flooding the network with routing packets, the flooding approach allows for the discovery of routes. By using this technique, routing packets go around the network endlessly, consuming bandwidth and battery life in the process as well as degrading throughput. Clustering and effective flooding techniques are two options to address the mentioned issue. In order to create clusters and choose a cluster head for a homogeneous network, the researchers have proposed many methods. Here, the recommended method is run via a network simulation and its performance is assessed over a range of parameters.

Keywords— Router, Clustering, Mobile Ad-hoc Network (MANET), EFWCA., Algorithm.

1. Introduction

A wireless network is made up of a number of radio-connected wireless devices, including laptops, that can communicate through a variety of networks and forward data packets to one another. Every device functions as both a host and a router, and they may each be modified as needed. Regarding mobile ad hoc networks, routing is a crucial method of data transfer. In a highly unpredictable network, the clustering method is used to improve routing efficiency. The goal of clustering is to minimize the routing overhead that results from generic routing methods overwhelming the network with routing messages. By dividing the network perimeter into logical zones, clustering operates. A logical zone is formed based on certain characteristics, like neighboring 1-hop and k-hop. One capable device, known as the cluster head, is granted complete authority over the built zone. Nodes are classified as cluster-heads, gateways, members, or regular nodes based on their roles and duties in clustering. One method in clustering is the election of the cluster leader, which is carried out by adhering to various protocols and upholding various standards. Packets are sent to the cluster head by ordinary nodes or member nodes, or they are forwarded to the gateway node. The packets are subsequently forwarded to additional clusters by gateway nodes. A comparative analysis of several well-known cluster-head election strategies is presented in this research. identifying certain alternative routes that are beneficial for route stability and high performance, including identifying a good neighbor and logically partitioning the network perimeter, is necessary to provide effective and efficient routing [1].

Clustering is the process of breaking down a large network into smaller, connected subnetworks or substructures. The first step in using the clustering technique is to define the three main categories of network nodes: gateway, cluster head, and cluster member. By using a certain measurement or combination of metrics, such as node degree, node mobility, node weight, etc., other member nodes elect the cluster leader. In addition to acting as the cluster's coordinator, a cluster head keeps track of crucial information about the clustering method, facilitating node communication and path construction. A cluster gateway is a shared node that connects clusters and is in charge of transmitting routing information between them. The remaining nodes that aren't chosen to be the cluster's head or gateway are known as cluster members. Packets are routed either to the gateway node or the head node via member nodes [2-4].

2. Litrature Review

Certain types of networks, known as mobile ad-hoc networks, can readily deployed or set up without the need for centralized management systems or pre-existing equipment. Because mobile nodes are dynamic and have limited battery life, MANETs operate in a difficult environment. The nodes can be organized into clusters to achieve greater stability because of their dynamic nature. Space is available for multiple nodes in each cluster. A cluster head (CH) is chosen from among the nodes based on a system or measurement standard.

Weighted clustering techniques were surveyed by Mirjeta Alinci and Evjola Spaho. The combined weight in weighted clustering algorithms is determined by several factors, such as the degree of nodes, speed, distance, etc. The weight of every node determines who will be the cluster head. Owing to their mobility, nodes occasionally depart from their current location, which has an impact on the system as a whole. Before beginning the clustering process, each node must keep its routing tables and be aware of the weight of every other node, which results in a large cost.[5]

An improvement to WCA, the flexible weighted clustering method based on battery power was proposed by Abdul Rahman and Amer Salem. When employing this method, there are very few clusters and a high degree of stability. It reduces the overhead by keeping a node for cluster-head election powered down by batteries. The evaluation of the algorithm's performance depends on several parameters, such as the total number of clusters formed, the total number of alterations made to the cluster heads, the frequency of re-affiliation, stability, and node longevity. The simulation results show that the algorithm improves load balancing and performs better than the original WCA; nonetheless, overall performance decreases as network traffic increases during the cluster head election process. [6]

To improve the network's performance, R. Pandi Selvam and V. Palanisamy created a flexible and reliable weight-based clustering technique. Each node's weight is taken into account while choosing the cluster head. The factors used to calculate the weights are degree difference (Dv), summation of distances (Pv), mobility (Mv), and cumulative time (Tv). Following the weight calculation, each node votes for a cluster head by comparing its weight to the weights of the nodes that are closest to it within two hops. The weight-based clustering approach with two hops can significantly reduce the number of clusters. The cluster leader shall be proclaimed by the node with the highest weight. This technique is appropriate for various applications and situations and outperforms the conventional and current LID, HD, and WCA. [7]

Mrinal Kanti, Pritam Kar, and Piyalikar Deb Barma gave an explanation of MANET's Forecast Weighted Clustering. A cluster head oversees the routing procedure in this cluster-based routing protocol and keeps track of details like cluster membership and cluster linkages, which allow inter-cluster routes to be dynamically found. By selecting the most eligible node as the cluster head and taking into consideration the nodes' past weight values, FWCA lowers the overall overhead incurred. Weighted Clustering Algorithm is outperformed by FWCA in terms of performance; nevertheless, overhead rises as a result of keeping all of the nodes' prior values. [8]

3. Problem Defination and Proposed Solution

Every node in an ad-hoc network is free to roam across the network without requiring synchronization. Numerous operations have the potential to lower network performance, which in turn affects how much end-to-end communication occurs. There is no standard in networking for the equitable distribution of cluster head elections. But WCA frequently results in the incorrect cluster-head election. By maintaining the historical weighted values of the nodes separate from the present value, FWCA solves this difficulty. Although FWCA provides accurate cluster head election, maintaining past values demands more memory. It is also not appropriate for a diverse MANET environment and results in significant processing cost.

A unique method for electing the cluster head is suggested in order to resolve this FWCA issue and make it work well in a heterogeneous setting. In contrast to FWCA, only the nodes that did not acquire a new weighted value will retain their original values using this method. Thus, it lowers computational overhead and the need for memory to hold data. The weighted clustering algorithm is used to calculate each node's weight in the following way -

$w_I = w_I*ss_I + w_{II}*tp_I + w_{III}*st_I + w_4*tr_I$

Where, tp_I= Transmission power, ss_I= signal strength, st = Stay time, w_I, w_{II}, w_{III} and w_{IV} are the weight factors, tr_I= Transmission range, for the corresponding system parameters.

Algorithm

An algorithm has been developed to comprehend the operation of the suggested methodology, which is expressed in the form of pseudocode. "The designed algorithm defines an array of nodes, transmission power, signal strength, transmission range and stay time by starting the declaration of variables in a sequential order". The algorithm makes use of some commands, like "send" and "receive." The procedure is shown below, where each node finds its neighbors by sending a greeting packet to node j and then repeating the process to n nodes. The election procedure to choose the cluster head will then begin based on minimum.

Algo CHE (n [ ], i_d)

{

DECLARE i, j, ss, tp, st, tr, w;

Repeat I=1 to n

{

Send (hello, Node[i], Node[j]);

For all nodes

(Node[j] ==i_d) in receive (hello, i_d) nb_I (Node[i], Node[j]) =1

"//Calculate signal strength, transmission power, stay time and range of neighbour's nodes".

//Determine weighted value of each node using conditional formula. Elect cluster head with lowest weighted value.

If (Node[i] -> receive (hello)! =NULL)

{

$w_I = w_I*ss_I + w_{II}*tp_I + w_{III}*st_I + w_4*tr_I$

}

calculated weight. The cluster head is designated as the node with the lowest weight. Each node determines its weight value depending on a few parameters: nearby nodes' range, stay time, transmission power, and signal intensity. Finally, a cluster head decision is made, and the procedure is ended.

Else

{

$\mathbf{EFW_0 = \alpha W_{present} + (1 - \alpha) * EFW_{previous}}$

$w_I = w_I*ss_I + w_{II}*tp_I + w_{III}*st_I + w_4*tr_I$

}

}

4. Result analysis

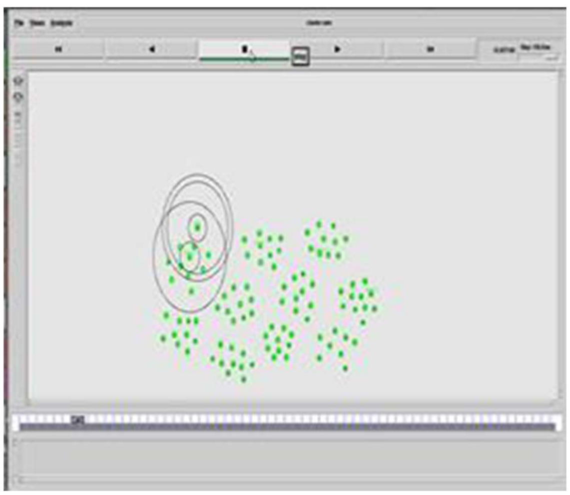
"A discrete event simulator called Ns is used in networking research. Broad support for simulating TCP and routing protocols over wired and wireless (local and satellite) networks is provided by NS. In essence, a simulator model in a real-world system is a simplified version of the real-world system. Some of the boundaries of the simulation model that are personified in the present version of NS-2 are explained in this explanation. Table 1 presents a simulation network scenario and a proposed approach that takes into account many parameters".

TABLE I. N/W PARAMETERS AND VALUES

N/W Parameters	**Value**
No. of nodes	41-100
Dimension (simulated area)	1000×1000
Simulation time (Sec)	50
Radio Range	100m
Traffic type	CBR, 3pkts/s
Packet size (bytes)	512
Routing Protocol	DSR
Connection Type	TCP

The simulation scenario depicted in Figures 1 and 2 is produced by simulating the proposed approach using Table 1 parameters.

Fig. 1. Simulation scenario



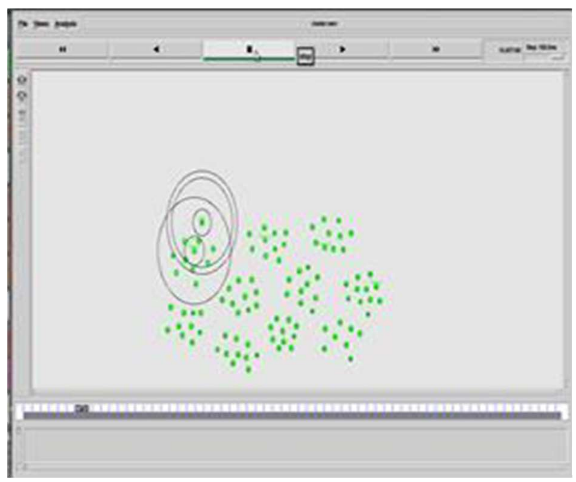


Fig. 2. Simulation scenario

The suggested approach's outcome analysis is computed based on multiple parameters. The approach's goal is to reduce computational overhead while choosing the right cluster head. The following evaluation parameters are taken into account while assessing the network performance.

- Throughput
- Routing Overload
- Residual Energy

Thruput - Achievement Throughput is the number of data units received in the form of bits, bytes, or packets per unit of time. Number of packets received / unit time equals throughput. The various values that were obtained and displayed in the following figures correspond to time scales of 10, 20, 30, 40, and so forth. The throughput of the suggested cluster head election technique is displayed in Fig. 3, where throughput is expressed in bytes/sec with regard to time.

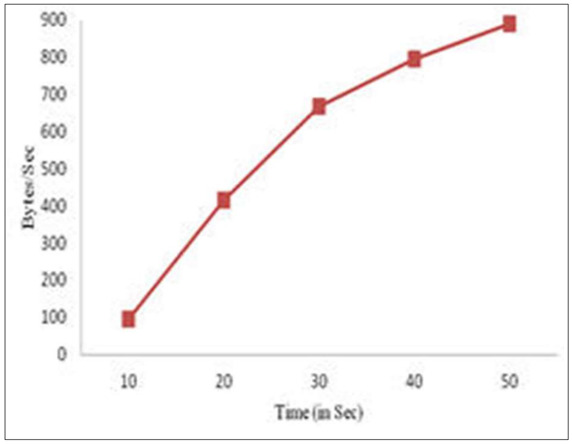


Fig. 3. Throughput Graph

The throughput of the generic cluster head election technique is displayed in Fig. 4, where throughput is expressed in bytes/sec with regard to time.

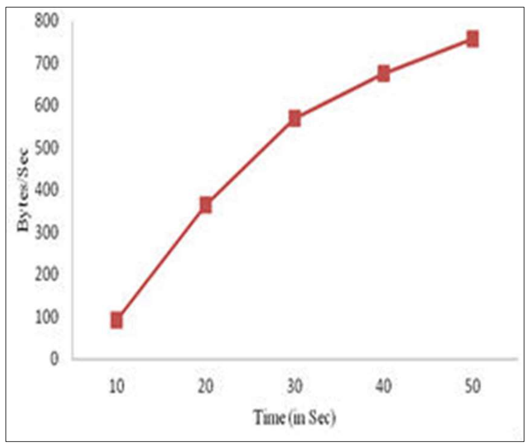


Fig. 4. Throughput Graph

The throughput of both generic cluster head election techniques is displayed in Fig. 5, where throughput is measured and contrasted in bytes/sec with respect to time.

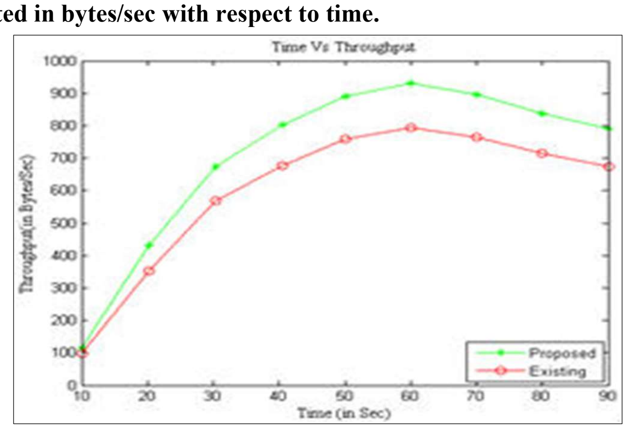
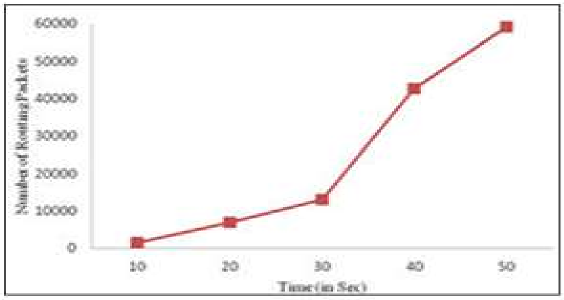


Fig. 5. Throughput Graph

Routing Overload: The quantity of routing packets sent over a network during route maintenance and

discovery is known as routing overhead. The routing overhead of the suggested cluster head election technique is depicted in Fig. 6, where the overhead is expressed as the number of routing packets relative to time.



The routing overhead of the general cluster head election technique is depicted in Fig. 7, where the overhead is expressed as the number of routing packets relative to time.

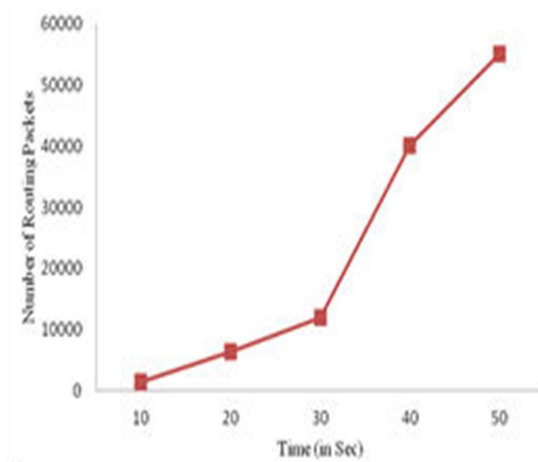


Fig. 7 Routing Overhead Graph

The routing overhead of the two cluster head election techniques is displayed in Fig. 8, where the overhead is calculated and compared in terms of the number of routing packets in relation to time.

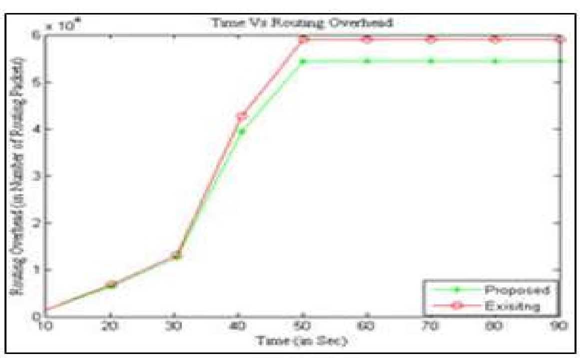


Fig. 8. Routing Overhead Graph

Residual Energy: This is the energy that network nodes have left over after the network has finished operating.

The residual energy of the suggested cluster head election technique is depicted in Fig. 9. It is calculated as the energy of each node that remains after the full transmission and is expressed in Joule units according to node number. Depending on the number of nodes, different energy values are produced, like example 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10……39.**Fig. 6 Routing Overhead Graph**

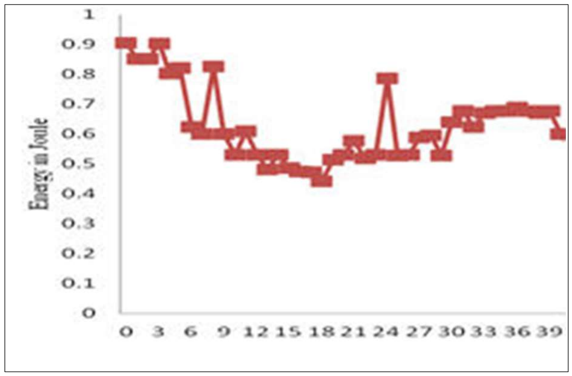


Fig. 9 Residual Energy Graph

The residual energy of the generic cluster head election technique is displayed in Fig. 10. This approach calculates the energy of each node that remains after the entire transmission and represents it in joule units according to node number. Depending on the number of nodes, various energy values are produced, such : 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 39.

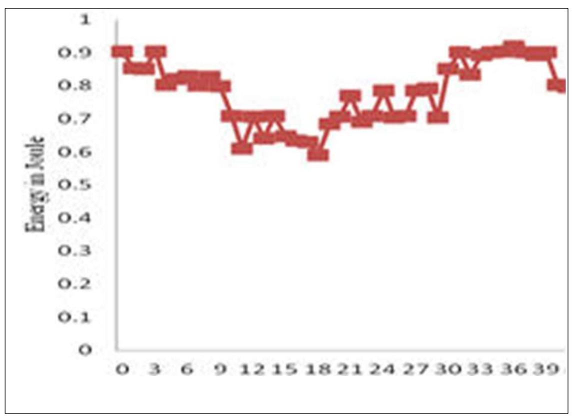


Fig. 10 Residual Energy Graph

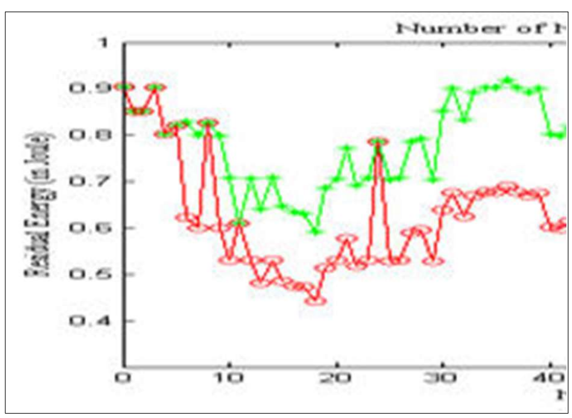


Fig. 11. Residual Energy Graph

The residual energy of the two cluster head election techniques is depicted in Figure 11, which compares and determines the energy of each node remaining after the full transmission and is expressed in Joule units relative to node number. Depending on the number of nodes, various energy values are produced, such : 0, 1, 2, 3, 4, 5, 6, 7, 8, 9,10…..39.

The comparison between the suggested algorithm (EFWCA) and the previous algorithm (FWCA) with varying parameters is displayed in fig 5, 8, and 11. Throughput is used to conduct the simulation outcomes.

5. Conclusion

One important method for setting up a mobile ad hoc network is clustering. Network complexity is decreased and routing is processed more effectively with the aid of clustering.
The nodes' residual energy and routing overhead. The outcomes demonstrate that, in a heterogeneous context, our Enhanced Forecast Weighted Clustering Algorithm produces superior results with less overhead.
"Several clustering methods that aid in the hierarchical establishment of MANETs have been examined, and their primary characteristics are outlined. Through analysis, it becomes clear that a cluster-based MANET has a number of important concerns to keep an eye on, including the stability of the cluster structure, controlling the overhead of cluster building and conservation, the energy consumption of mobile nodes with different cluster-related statuses, and the distribution of traffic load within clusters. Therefore, a solution that verifies the choice of a reliable cluster head capable of managing high traffic levels without sacrificing stability is required. To achieve this, a method for choosing an appropriate cluster head is presented in order to lower computational cost and enhance network performance".

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